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SPATIAL CHARACTERISTICS OF THE 630-NM ARTIFICIAL IONOSPHERIC AIRGLOW GENERATION REGION DURING THE SURA FACILITY PUMPING

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We describe the method and the results of modeling and retrieval of the spatial distribution of excited oxygen atoms in the HF-pumped ionospheric region based on two-station records of artificial airglow in the red line ($\lambda = 630$ nm). The HF ionospheric pumping was provided by the Sura facility. The red-line records of the night-sky portraits were obtained at two reception points — directly at the heating facility and 170 km east of it. The results were compared with the vertical ionospheric sounding data. It was found that in the course of the experiments the airglow region was about 250 km high and did not depend on the altitude of the pump-wave resonance. The characteristic size of the region was 35 km, and the shape of the distribution isosurfaces was well described by oblique spheroids or a drop-shaped form. The average value of the maximum concentration of excited atoms during the experiment was about 1000 cm^{-3}.

1. INTRODUCTION

Artificial airglow is observed in the ionospheric F region under the action of high-power electromagnetic emission as a result of the following chain of phenomena: 1) interaction of the O-mode pump wave at a frequency f_0 less than the cut-off frequency f_{0F_2} of the ionospheric F_2 layer with the ionospheric plasma leads to the generation of plasma waves in the reflection region of the pump wave; 2) plasma waves effectively accelerate free electrons; 3) the electrons acquiring the necessary energy $\mathcal{E} > \mathcal{E}_{\text{ex}}$ as a result of acceleration excite certain energy levels of neutral atoms of the ionospheric gas during collisions; 4) a photon is emitted as the excited atom relaxes to the ground state. The main airglow line observed at the Sura heating facility (town Vasilsursk of the Nizhny Novgorod) is the red line ($\lambda = 630$ nm), which is related to the radiation of atomic oxygen in the transition of an electron from the level O(^{1}D) to the ground state O(^{3}P) with the excitation energy $\mathcal{E}_{\text{ex}} = 1.96$ eV and the lifetime $\widetilde{\tau} = 10^{-7}$ s.

Since the 1970s, the recording and analysis of the characteristics of artificial airglow have been used, along with the vertical/oblique sounding of the ionosphere, recording of stimulated electromagnetic emission, etc., to diagnose the HF-pumped ionospheric region [1]. Most of the experiments on airglow recording are carried out at one point located near the heating facility. In this case, the spatial parameters of the airglow region cannot be determined. Nevertheless, the question of how the altitude of the airglow region correlates with the plasma resonance regions is important. In the case of the artificial glow recording at several spatially separated points, it becomes possible to estimate the spatial characteristics of the airglow region, and to

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